Protection Branch Report of Test No. 13-61

INVESTIGATION OF BACTERIAL CONTAMINATION INSIDE ELECTRONIC COMPONENTS. TEST IV.

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This investigation was undertaken to determine whether electronic components were sterile after exposure to dry heat at 125° C for 27 hours. Dry heat is currently being considered as the ultimate means of sterilizing not only electronic components but an entire spacecraft encased in a microbial proof shroud. No other method of sterilizing can be employed as conveniently and inexpensively for the complete sterilization of a spacecraft in one operation. Radiation, for example, would require very expensive, unwieldly equipment and chemical gases will sterilize only accessable surfaces but not sealed interiors of components and materials. Thus heat is the ideal sterilizing method for spacecraft, although it may have to be followed by a terminal surface sterilization treatment, if the object is subsequently handled. The use of heat as the sterilization procedure is, of course, dependent on the ability of engineers to construct a heat stable payload. At the present time not all components designated for scheduled near-future spacecraft can withstand the minimum sterilizing temperature of 125° C. The exact exposure time required at 125° C to effect sterilization is as yet undetermined, however, it has been shown [1/] that a $13\frac{1}{2}$ hour exposure to 125° C can not be relied upon to sterilize the interiors of resistors and capacitors.

In order to help establish a time temperature relationship for internal sterilization of electronic components, a number of capacitors, resistors, cores and chokes about half of which heated at Jet Propulsion Laboratory, were sent to Fort Detrick in July 1960 to be tested for internal sterility.

MATERIALS AND METHODS

A total of 218 electronic components were received from Jet Propulsion Laboratory and, of these, 111 had been subjected to dry heat (125° C) for 27 hours.

In each test, for internal sterility, several electronic components of the same variety and type (either heated or not heated), tools needed to break and grind the components, and fluid thioglycollate medium blanks sealed with tape were placed in a plastic chamber and exposed to ethylene oxide gas for six hours. After aerating the chamber 16 hours, each electronic component was broken, ground as well as possible, and the pieces put into a fluid thioglycollate medium blank to incubate at 37 C. A detailed description of the above procedure is given in Protection Branch Report of Test No. 7-60 [2]. In addition to breaking the components open to determine internal bacterial contamination, one or two components of the same variety and type per test were put into fluid thioglycollate medium whole in order to determine whether the exterior surfaces were sterilized with ethylene oxide gas in the prescribed six hour exposure period.

After the samples had incubated at 37 C for seven days, an aliquot of each sample was streaked on tryptose agar to check for bacterial growth. A methylene blue stain of each sample was examined microscopically for microorganisms and compared with a stain of bacteria from agar if growth occurred. Finally, if no microorganisms grew on agar or if no microorganisms were seen during examination of the methylene blue stain of the fluid thioglycollate sample, the sample was inoculated with one to ten Staphylococcus aureus cells from a diluted 24 hour tryptose broth culture, to assure that the medium was capable of supporting bacterial growth.

Previously*, tryptose broth was the medium used to propagate aerobic bacteria that might be inside an electronic component. Subcultures in tryptose broth serve to eliminate possible inhibition caused by some materials in some components; subcultures in fluid thioglycollate medium were used in addition to tryptose broth in order to detect anaerobic bacteria. Although subcultureing is a satisfactory means of eliminating inhibition, there is always the probability that if only a few bacteria were present in the original sample, none of these may be transferred to the subculture and lightly contaminated objects may be mistaked as sterile. Consequently a change was made in the procedure, and fluid thioglycollate medium, which has the ability to neutralize inhibitory effects of some materials and will propagate both aerobic and anaerobic bacteria, was adopted as the medium for testing the sterility of electronic components.

* A detailed description of the procedure discussed in this paragraph is given in Reference 1.

Moreover, since inhibition caused by some materials in some components might be sufficient to prevent propagation of bacteria if only a few microorganisms are present, only one to ten cells of S. aureus instead of a hundred or more were introduced into the medium to verify that the medium was capable of supporting bacterial growth in the presence of an electronic component.

RESULTS AND DISCUSSION

For the first time when testing a large number of components all were found to be internally sterile. No internal bacterial contamination was evident in any of the capacitors, resistors, cores, or chokes whether unheated or heated at 125 C for 27 hours (Tables I and II). Until this test, approximately seven per cent of these types of electronic components were found to be internally contaminated. The external surfaces of all electronic components tested were sterile after exposure to ethylene oxide gas for six hours. Moreover, none of the electronic components tested would have inhibited growth of microorganisms if they had been present since the few cells of S. aureus introduced propagated in the medium containing an electronic component.

Whether or not dry heat at 125 C for 27 hours is sufficient to sterilize electronic components that have internal bacterial contamination can not be determined from these data since all the components not subjected to heat were apparently sterile too.

References

1. Report of Test No. 24-60: "Investigation of Bacterial Contamination Inside Electronic Components. Test II", dated 21 June 1960.

2. Report of Test No. 7-60: "A Technique for the Investigation of Bacterial Contamination Inside Electronic Components", dated 11 March 1960.

Table I.

Variety and Number of Capacitors Internally Contaminated

Variety of Capacitor	Manufacturer	No. Contaminated/No. Tested	
		Not heated	125C/27 hrs
CK61Y, 152Z (Ceramic disc)	Erie	0/8	0/7
75V, .01, (Ceramic)	Glenco	0/8	0/8
S2L, 56K, 1KV	Maida	0/8	0/8
287A, HiQ 1200, 10%	Maida	0/3	0/4
287A, MDC 1000, GMV	Maida	0/8	0/8
947, 150D476x003552 (Tantalum)	Sprague	0/4	0/4
150D476x003552 (Tantalum)	Sprague	0/5	0/6
MQ-106, Quartz, Piston	JFD	0/4	0/4
VC-23G, Glass, Variable	JFD	0/4	0/4
DM-15, Dipped Mica	Elmenco	0/12	0/12

Table II.

Type, Variety, and Number of Resistors, Cores, and Chokes Internally Contaminated

Type and Variety of Component	Manufacturer	No. Contaminated/No. Tested	
		Not Heated	125 C/27 hrs
Resistor: C-170N, 1K, 1%	Mepco	0/8	0/8
Resistor: CB-1/4	Allen-Bradley	0/16	0/16
Resistor: RN60B (1001F)	Texas Instrument	0/8	0/8
Core: T37-6, Carbonyl SF	Micrometals	0/3	0/4
Core: T37-7, Carbonyl TH, Lot 16	Micrometals	0/3	0/4
Core: T37-10, Carbonyl W, Lot 15	Micrometals	0/3	0/4
Choke: 4.7uHy	NYT	0/2	0/2